Active Systems Development at NASA Langley Research Center for Space based Applications

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Outline

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- Space Laser Applications for Science and Exploration
- Current Technology Development
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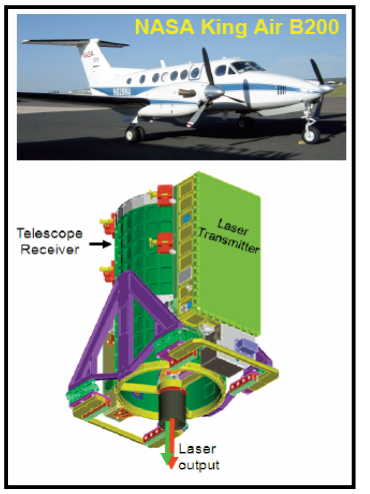
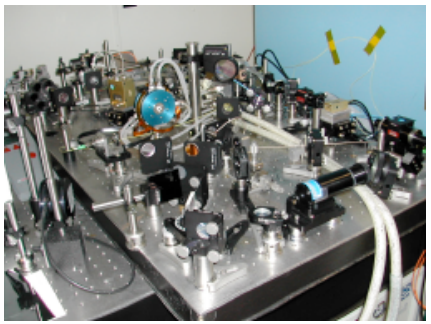
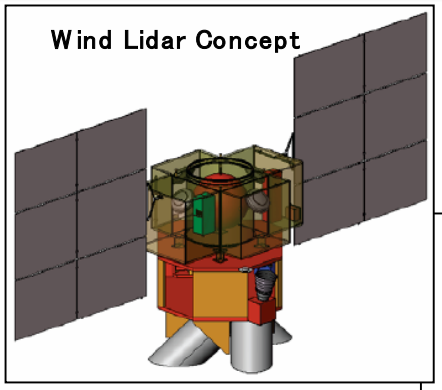
  - Instrument Incubator Program (IIP)
  - Other research activities
- Conclusion

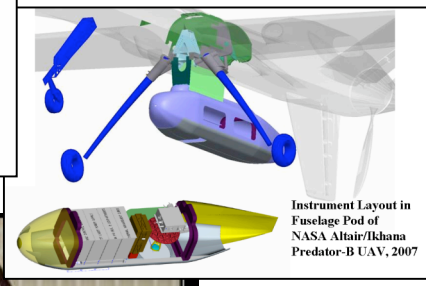


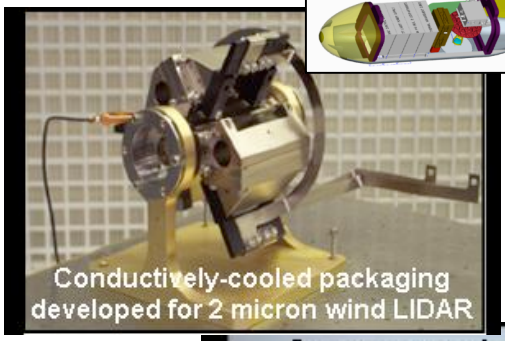


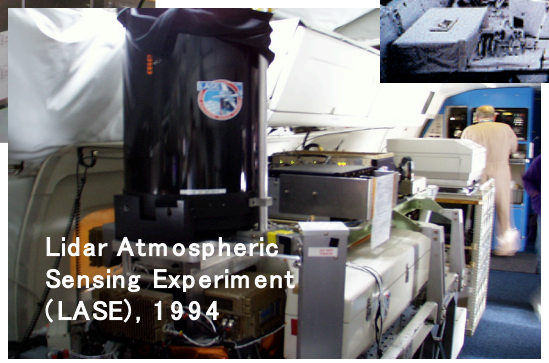
Background

Langley has over 29 years experience in fundamental laser research, concept demonstrations, instrument (design, build and testing) of LIDAR instruments for ground, airborne and









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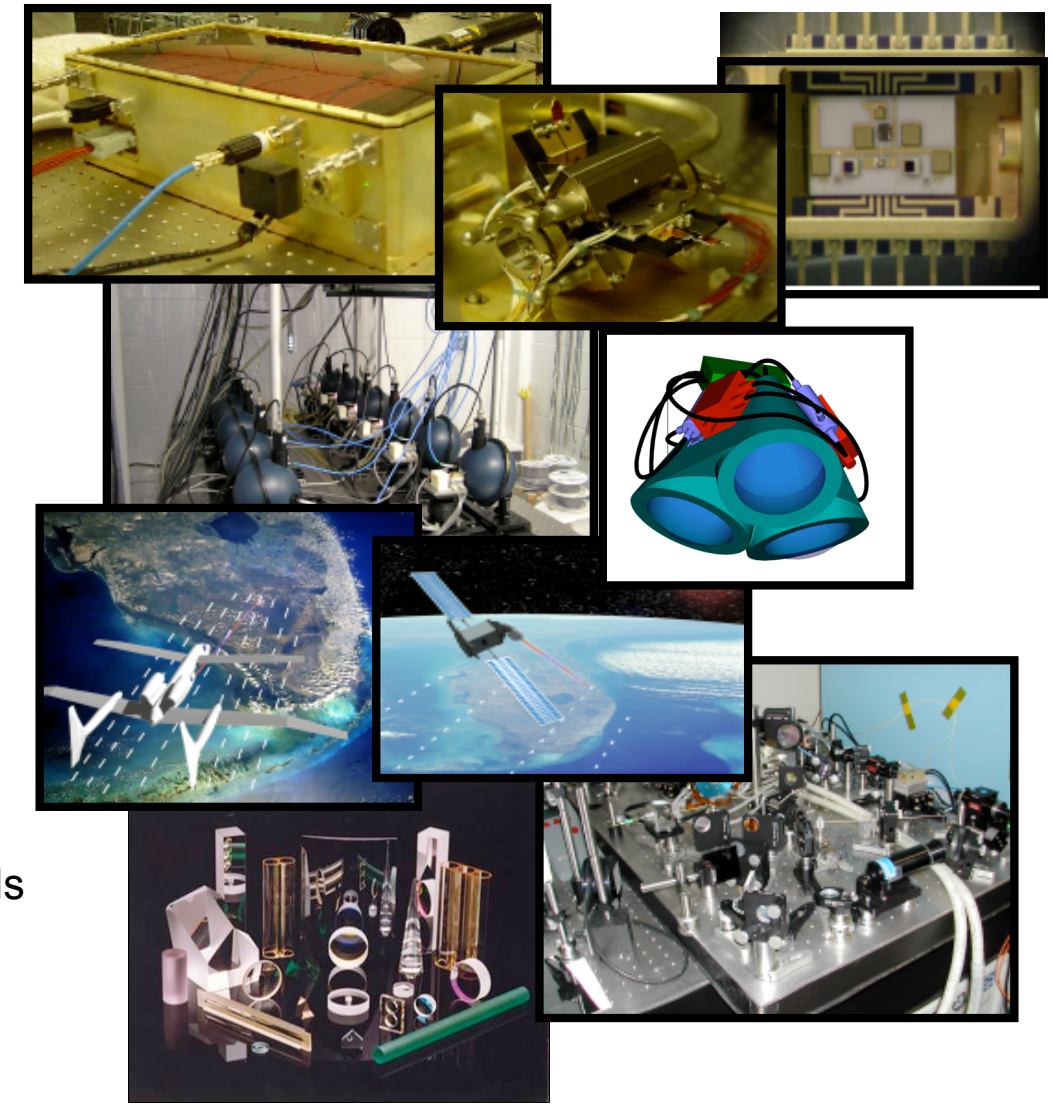
Laser Technology Development Overview

- **Studies, Modeling, Optical Characterization**
  - Laser mission concept studies
  - Quantum Mechanical Modeling
  - 0.3–15 micron spectroscopy
  - Laser material characterization
- **Laser & Receiver Component Technologies**
  - Laser diode characterization
  - High power 2-micron lasers and high efficiency detectors
  - Direct and Coherent LIDAR receivers
- **LIDAR Instrument and Application Development**
  - Techniques for monitoring global winds on Earth and Mars
  - CO_2, Ozone and water vapor DIAL
  - Ranging, velocity, Hazard avoidance



Laser Technology Earth Science Decadal Survey Alignment

Timeframe: 2013 – 2016, Missions listed by cost			
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer
ASCENDS	Day/night, all-latitude, all-season CO_2 column integrals for climate emissions	LEO, SSO	Multifrequency laser
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka-band wide swath radar C-band radar
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar
Timeframe: 2016 -2020, Missions listed by cost			
LIST	Land surface topography for landslide hazards and water runoff	LEO, SSO	Laser altimeter
PATH	High frequency, all-weather temperature and humidity soundings for weather forecasting and SST[a]	GEO	MW array spectrometer
GRACE-II	High temporal resolution gravity fields for tracking large-scale water movement	LEO, SSO	Microwave or laser ranging system
SCLP	Snow accumulation for fresh water availability	LEO, SSO	Ku and X-band radars K and Ka-band radiometers
GACM	Ozone and related gases for intercontinental air quality and stratospheric ozone layer prediction	LEO, SSO	UV spectrometer IR spectrometer Microwave limb sounder
3D-Winds (Demo)	Tropospheric winds for weather forecasting and pollution transport	LEO, SSO	Doppler lidar

Source: *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* , National Research Council, 200 ,

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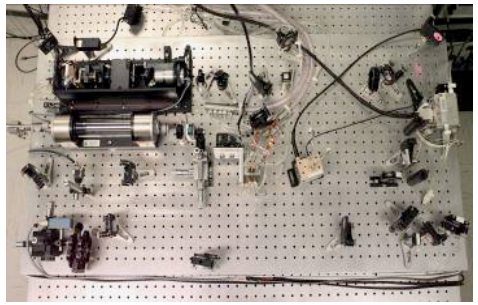
Current Technology Projects

Development and Evaluation of a 2-micron Differential Absorption Lidar (DIAL) for profiling CO_2

PI: Dr Syed Ismail, NASA Langley Research Center

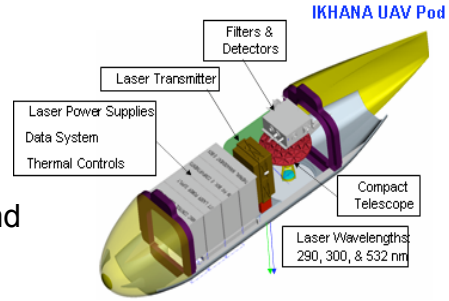
Objective: Develop and validate a 2-micron DIAL instrument for CO2 field studies and technology validation as an interim step towards the development of a space-based system



Development of UAV-based Global Ozone Lidar Demonstrator (GOLD)

PI: Dr Edward V. Browell, NASA Langley Research Center

Objective: (1) Advance key technologies to enable space-based ozone LIDAR development. (2) Develop compact UAV-based Ozone LIDAR for new global Ozone and aerosol investigation.
(3) Demonstrate high-altitude Ozone LIDAR using airborne (290 & 300 nm) Ozone LIDAR wavelengths



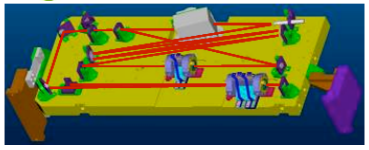
Doppler Aerosol WiNd Lidar (DAWN)

Compact, Engineered, 2-Micron Coherent Doppler Wind Lidar Prototype for Field and Airborne Validation

PI: Dr Michael Kavaya, NASA Langley Research Center

Objective: (1) Advancement of 2-micron laser technology towards a packaged, ruggedized system with a direct path to aircraft and space-flight systems.
(2) Packaging and hardening of technologies.
(3) Advance the technology readiness of 2-micron laser components to address the future development of Global Tropospheric Wind Missions

Laser Oscillator and Amplifier Heads

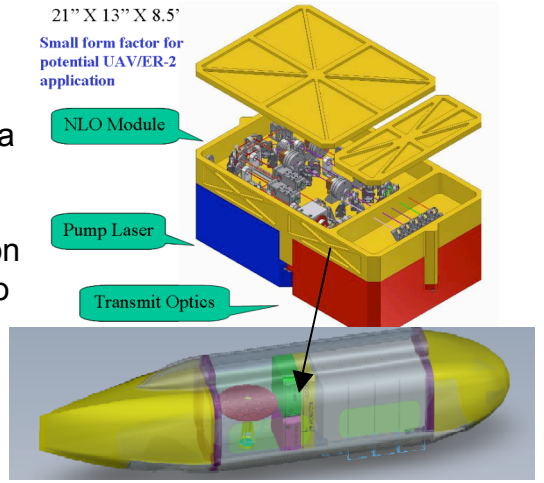


Planned Optical Bench Layout 9.6 x 21.6 in

Technology Development for a Combined HSRL and O_3 DIAL Lidar

PI: Dr Chris A. Hostetler, NASA Langley Research Center

Objective: Develop transmitter and receiver technologies suitable for a combined High Spectral Resolution Lidar (HSRL) and Differential Absorption Lidar (DIAL) instrument to measure tropospheric aerosols and ozone.



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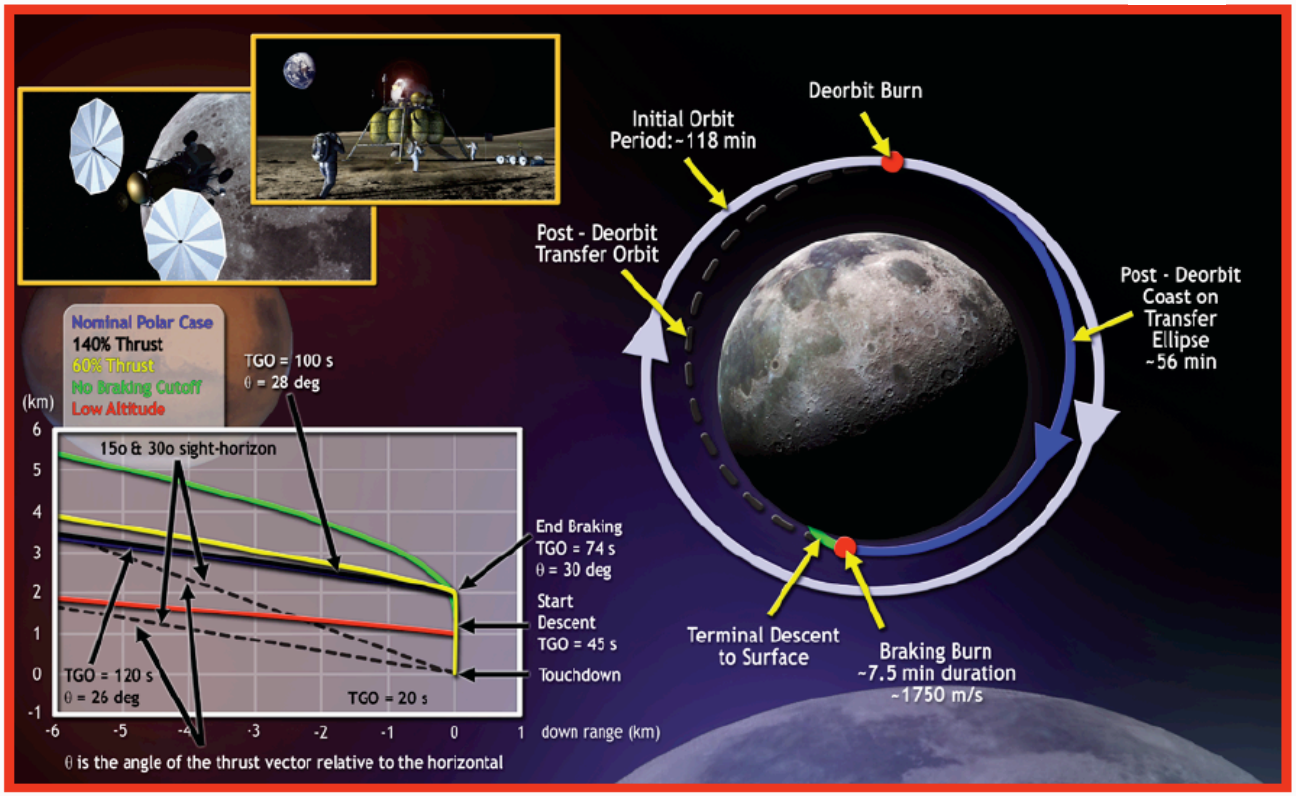
ALHAT -- Autonomous precision Landing and Hazard detection and Avoidance Technology

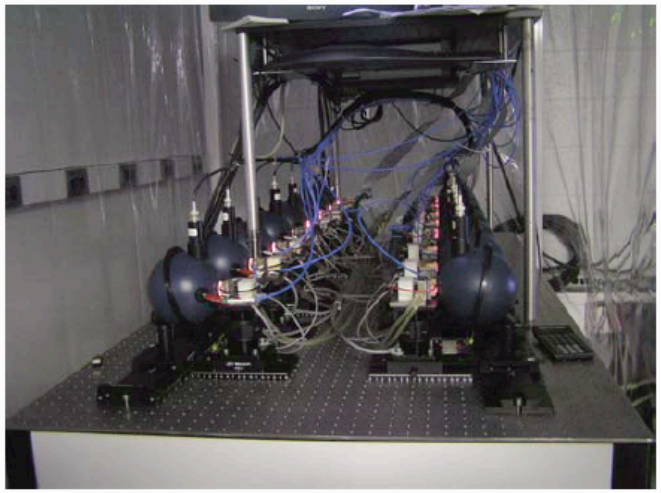


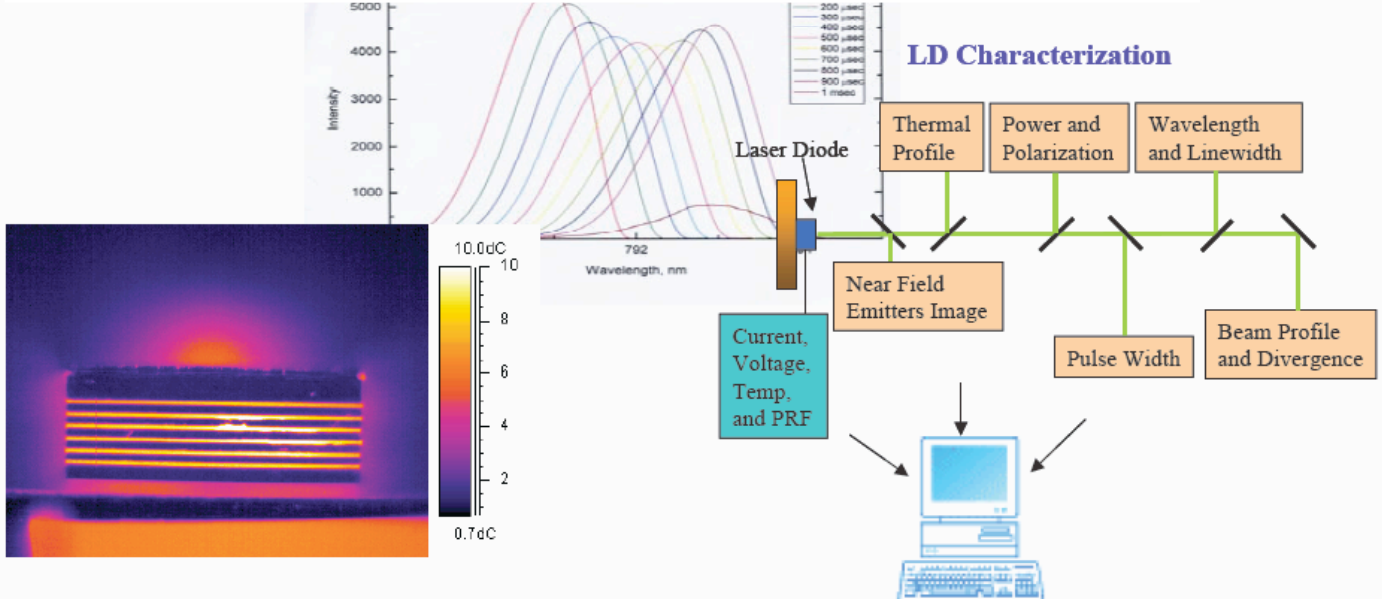
ALHAT Objectives:

- Autonomous Precision Lunar Landing – Descent and landing systems for crewed and non-crewed lunar missions capable of landing within 10's of meters of predefined surface features or previously deployed assets.
- Autonomous Hazard Avoidance – Ability to reach landing sites which may lie in areas containing hazardous terrain features such as craters, slopes, and rocks.

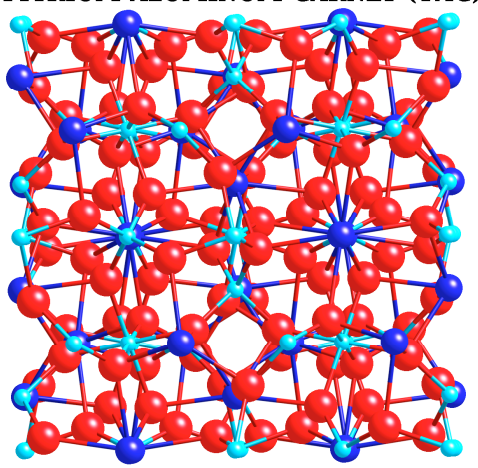
LRRP Diode Laser Pump Array Characterization

- Developed sophisticated Laser Diode Array (LDA) Characterization Facility
- Developed 16-station LDA Lifetime Test Facility
- Improved LDA heat removal with novel diamond substrate
- Began development of lifetime theory
- Assisted ICESAT & CALIPSO flght missions





Quantum Mechanical Modeling



Cost effective design tool:

- Uses quantum mechanics
- Models the physics from lattice structure

Predicts new laser materials:

- Winds - Tm:Ho:LuAG, Tm:Ho:LuLF
- Water Vapor - Nd:YGAG, GYAG, YSAG

Predicts essential spectroscopic parameters:

- Energy levels (laser wavelengths)
- Lifetimes (laser storage efficiency)
- Energy transfer rates (laser modeling)

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If you have further questions today, please see a Partnership Consultant (look for a Bright Yellow badge) or visit the booth on How To Work With Langley